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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: **John N. Glover**		Examiner: **David L. Sorkin**
Serial No.: **09/320,950**		Art Unit: **1723**
Filed: **May 27, 1999**		Attorney Docket No. **105218.04**
For: **FILTERING MEDIUM AND METHOD FOR CONTACTING SOLIDS CONTAINING FEEDS FOR CHEMICAL REACTORS**		

SUPPLEMENTAL DECLARATION OF JOHN N. GLOVER

I, John N. Glover, declare that I am over the age of twenty-one (21) years of age and am fully competent to make this declaration. I have personal knowledge of the facts set forth in this declaration and they are true and correct. I declare:

1. I am the President of Crystaphase International, Inc. and its related corporate entities (hereinafter "Crystaphase"), and maintain an office at Crystaphase at 16945 Northchase Drive, Suite 1610, Houston, TX, 77060-6029. I have been employed by Crystaphase since 1989 to the present as the President. I am the named inventor in the above-identified patent application and am familiar with the disclosure in the above-identified patent application.

2. I have worked in the petroleum refining and petrochemical industries for at least twenty-five years. I am familiar with ceramic filter units, catalysts, and recycling of these units.

3. I am a named inventor of the subject application and thus would be considered of above-ordinary skill in the art of ceramic filter units and associated methods. In my position of President, I have supervised numerous individuals and therefore am knowledgeable about the level of understanding of one with ordinary skill in the art in the field of ceramic filter units.

4. My educational experience includes undergraduate studies in Biology and Chemistry. I have performed numerous experiments on the subject matter of the above referenced patent application. I am extremely familiar with terms in the industry and the understanding associated with those terms throughout the industry

5. As discussed in my previous Declaration dated November 5, 2003, I participated in an experiment in which comparative performance data was obtained for ceramic filter units comparing ceramic units in accordance with embodiments of the presently claimed methods having combinations of elliptical and circular openings, along with flutes, to ceramic units in accordance with prior art units having combinations of circular openings and flutes (See Table I). Five prior art ceramic units (Products A, B, C, D, and E) were compared to three ceramic units made in accordance with the presently claimed embodiments (Products F, G, and H, as shown in FIG. 4 of the present application).

6. As discussed in my previous Declaration dated November 5, 2003, the maximum flow rate in a cell, among other parameters, was measured for all of the tested ceramic units. The maximum flow in a cell was determined by measuring the flow rates of each active cell and determining the highest flow rate of those cells. In this experiment, the lower the maximum flow rate, the better. The best performing ceramic unit tested was Product F with only a 4.46% maximum flow rate in any one cell (See Table I). The best performing prior art ceramic unit was Product C with an 8.45% maximum flow rate in any one cell (See Table I). The best embodiment of the presently claimed methods, Product F, performed approximately 47% better than the best performing prior art ceramic unit tested, Product C (See Table I).

7. In this Supplemental Declaration, new rows 10 and 11 have been added to the initial test results of Table I to demonstrate additional unexpected and surprisingly advantageous properties discovered by Applicant. In particular, rows 10 and 11 demonstrate that unit F having elliptical openings in an embodiment of the presently claimed methods has improved lateral displacement and volumetric distribution properties when compared to the prior art units A-E.

8. Table II of this Supplemental Declaration includes a second set of test results, in

which comparative performance data was obtained for ceramic filter units comparing ceramic units having trisoid shaped openings to ceramic units in accordance with prior art units having combinations of (i) triangular and (ii) circular, oval and triangular openings. The test results show that trisoid shaped openings (see Table II, column D) displayed unexpected and surprisingly advantageous fluid distribution properties, in particular, maximum flow rate and volumetric distribution, when compared to the prior art units of Table II, columns A-C, and of Table I, column C.

9. In Table II, the best performing ceramic unit tested was Applicant's Product D with only a 6.40% maximum flow rate in any one cell. In contrast, the best performing prior art ceramic unit in Table II was Product B with an 11.19% maximum flow rate in any one cell. The best performing prior art ceramic unit in Table I was Product C with an 8.45% maximum flow rate in any one cell. In other words, Applicant's Product D performed better than the best performing prior art ceramic units tested, Products C and B, from Tables I and II, respectively. Although Product D does not include a central opening, I believe that these test results are generally indicative of the fact that units having trisoid shaped openings such as Product D perform unexpectedly and surprisingly better than prior art units having differently shaped openings such as those tested herein.

10. Crystaphase has enjoyed much commercial success from the sale of these ceramic units. Crystaphase began selling the ceramic units made in accordance with embodiments of the presently claimed methods in 1998. Since then, Crystaphase has sold more than eight million dollars worth of units made in accordance with embodiments of the presently claimed methods, which approximates 40,000 cubic feet of product being sold, which correlates to about 30% - 35% of the total market in recent years. With so many units sold, the ceramic units should be deemed to have met an unfilled need in the industries in which these ceramic units have been sold.

11. I believe there is no motivation for one of ordinary skill in the field of ceramic filter units to utilize ceramic disc units containing a central circular opening and at least three elliptical openings, or trisoid shaped openings, in accordance with embodiments of the presently claimed methods, at least without resorting to hindsight after viewing the present invention.

12. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Sec. 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the publication or any patent issued thereon.

Date: 2/25/2008 [signature]

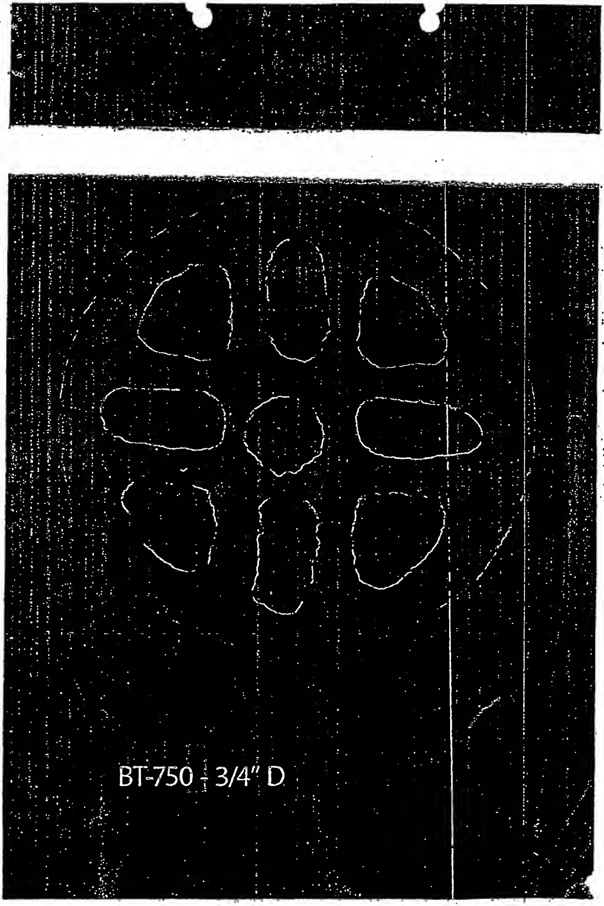
John N. Glover

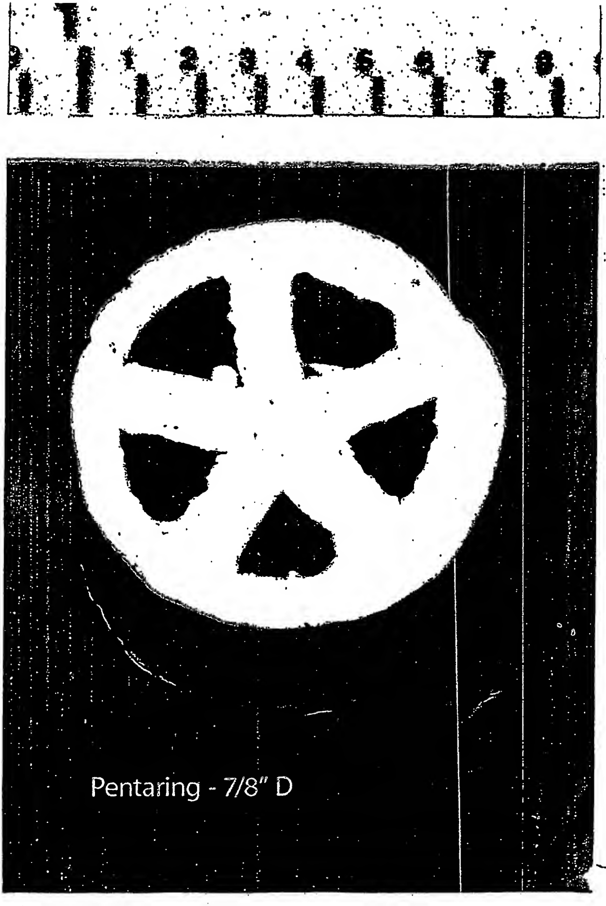
TABLE I - SUMMARY OF COLD FLOW EXPERIMENT RESULTS

Shape	PRIOR ART					PRESENT INVENTION		
	Spheres		Cylindrical Openings			Elliptical Openings		
Product	A (3/4" Ceramic balls)	B (3/4" Ceramic balls)	C (5/8" TK-10)	D (7/8" TK-10)	E (5/8" Dypor 607)	F (5/8" BG-1000)	G (7/8" BG-1000)	H (7/8" BG-1002)
Top layer – Depth	6"	12"	6"	6"	6"	6"	6"	6"
Shape	Sphere	Sphere	Disc with 7 cylindrical openings	Disc with 7 cylindrical openings	Disc with one cylindrical opening and six flutes	Disc with four elliptical and one central circular openings	Disc with four elliptical and one central cylindrical openings	Elongated Disc with four elliptical and one central cylindrical openings
Void space	n/a	n/a	55%	55%	60%	60%	60%	63%
Bottom layer – Depth	6"	-	6"	6"	6"	6"	6"	6"
Size and Shape	¾" Sphere	-	¾" Sphere	¾" Sphere	¾" Sphere	¾" Sphere	¾" Sphere	¾" Sphere
Void space	~39 %	-	~39 %	~39 %	~39 %	~39 %	~39 %	~39 %
1. Total number of active cells	36	46	58	46	$\boxed{59}$	$\boxed{86}$	69	84
2. % of active cells	14.23%	18.18%	22.92%	18.18%	$\boxed{23.32\%}$	$\boxed{33.99\%}$	27.27%	33.20%
3. Area of Active Cells	49	100	$\boxed{143}$	72	120	$\boxed{180}$	121	153
4. Number of active cells greater than 5 cells distance from center	0	0	$\boxed{2}$	0	1	4	2	$\boxed{10}$
5. Number of active cells greater than 6 cells distance from center	0	0	$\boxed{0}$	0	0	0	0	$\boxed{3}$
6. Average Flow Rate per Active Cell	2.78%	2.17%	1.72%	2.17%	$\boxed{1.69\%}$	$\boxed{1.16\%}$	1.45%	1.19%
7. Maximum Flow Rate in a Cell	10.42%	7.03%	$\boxed{8.45\%}$	10.39%	9.07%	$\boxed{4.46\%}$	7.17%	9.74%
8. Percentage of active cells greater than 3% of total flow	27.78%	23.91%	$\boxed{17.24\%}$	26.09%	23.73%	10.47%	8.70%	$\boxed{8.33\%}$
9. Percentage of active cells greater than 5% of total flow	25.00%	8.70%	5.17%	6.52%	$\boxed{5.08\%}$	$\boxed{0.00\%}$	7.25%	3.57%
10. Lateral Displacement (0 – 100)	38.88	55.55	66.89	NA	$\boxed{NA}$	$\boxed{72.21}$	NA	NA
11. Volumetric Distribution (0 – 100)	71.04	69.04	71.83	NA	$\boxed{NA}$	$\boxed{79.00}$	NA	NA

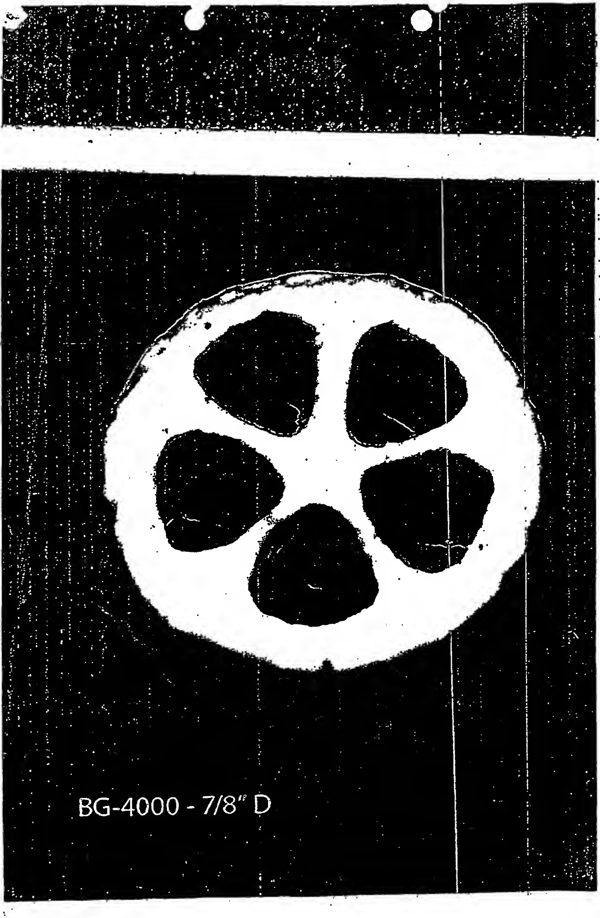
TABLE 2 - SUMMARY OF ADDITIONAL COLD FLOW EXPERIMENT RESULTS

Shape	PRIOR ART			PRESENT INVENTION
	Triangle Openings	Triangle Openings	Circular, Oval and Triangle Openings	Trisoid Openings
Product	A (1-3/4" AFS)	B (7/8" Pentaring)	C (3/4" BT-750)	D (7/8" BG-4000)
Top layer – Depth				
Shape	Disc with 265 triangle openings	Disc with five triangle openings	Disc with 1 central circular opening, four oval openings and four triangle openings	Disc with five trisoid openings
Void space	~75%	~60%	~55%	~60%
Bottom layer – Depth	0"	0"	0"	0"
Size and Shape				
Void space				
1. Total number of active cells	40	67	44	52
2. % of active cells	15.81%	26.48%	17.39%	20.55%
3. Area of Active Cells	132	143	100	144
4. Number of active cells greater than 5 cells distance from center	8	2	5	4
5. Number of active cells greater than 6 cells distance from center	3	0	0	1
6. Average Flow Rate per Active Cell	1.97%	1.41%	2.27%	$\boxed{1.92\%}$
7. Maximum Flow Rate in a Cell	15.00%	11.19%	14.17%	$\boxed{6.40\%}$
8. Percentage of active cells greater than 3% of total flow	2.77%	2.77%	3.56%	3.95%
9. Percentage of active cells greater than 5% of total flow	1.58%	1.58%	1.19%	0.79%
10. Lateral Displacement (0 – 100)	63.94	66.89	55.55	66.66
11. Volumetric Distribution (0 – 100)	50.32	63.87	75.00	$\boxed{85.56}$


BT-750 - 3/4" D



Pentaring - 7/8" D


BG-4000 - 7/8" D

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09/320,950	05/27/1999	JOHN N. GLOVER	2797.004	5662

7590 08/10/2009

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EXAMINER	
SORKIN, DAVID L	

ART UNIT	PAPER NUMBER
1797	

MAIL DATE	DELIVERY MODE
08/10/2009	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	09/320,950	GLOVER, JOHN N.	
	Examiner	Art Unit	
	DAVID L. SORKIN	1797	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11 June 2009*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *59,61-67 and 69-95* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *59,61-67 and 69-95* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 82-88 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement:

3. Regarding claims 82-85, the originally filed application makes no distinction between "sharp" corners and other corners. There is no description of corners being "sharp".

4. Regarding claims 86-88, the combination of "a central opening extending through the body, and at least three trisoid-shaped openings extending through the body and positioned between the central opening and an outer periphery of the body" was not described in the originally filed application.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 59, 61-67, 69-85, 94 and 95 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kramer (US 4,615,796) in view of "CE Refresher: Catalyst Engineering, Part 2" by John Fulton ("Fulton" herein). Regarding claims 59, 78, and 94

Kramer ('796) discloses a method of fluid distribution in a chemical reactor comprising the steps of providing a layer of a plurality of ceramic filter units (see col. 3, lines 34-40; Figs. 1 and 2); contacting an organic based stream with the layer of the plurality of ceramic filter units and passing the organic-based stream through the layer prior to the organic based feed stream contacting a catalyst be in the chemical reactor (see col. 2, lines 20-25; Figs. 1 and 2). Kramer ('796) fails to disclose the units having 3 or more passages surrounding a central passage, through which fluid flows (although annular units, including ones with passages are disclosed in Table 1). Fulton teaches cylindrical units having a central opening and four circular/elliptical openings between the central opening and the periphery (see Fig. 1, third column, fifth row). Note: it is considered that the broadest reasonable definition of ellipse includes circles; just as squares are a special type of rectangle, circles are a special type of ellipse. It is considered that it would have been obvious to one of ordinary skill in the art to have shaped the units of Kramer according to the teachings of Fulton, because Kramer explains that alternative unit shapes may be used in the disclosed processes (see Table 2 and col. 4, lines 1-4). Furthermore, Fulton teaches the above-mentioned shape as an alternative to other shapes including spheres (see page 97) and explains that passages in the units can significantly reduce the amount of material needed, while minimizing lose of strength (see pages 97 and 98, Fig. 3). See also the admitted prior art of page 3, lines 7-18 of the instant specification. Regarding claim 61, Kramer ('796) further discloses removing contaminants from a contaminated stream; and providing the contaminated stream to a catalyst bed for further processing in the chemical reactor (see col. 1, lines 52-60; col. 3,

lines 4-22; Figs. 1 and 2). Regarding claims 62 and 63, because "packing factor" can be set to any value for a given shape unit merely be varying the size of the unit, and Kramer ('796) explains that unit size should be selected to according to an expected particle size to be filtered out, it is considered that it would have been obvious to one of ordinary skill in the art to have optimized the packing factor to suit a particular expected contaminate particle size. Further regarding claim 63, Kramer ('796) discloses packing the ceramic filter units in graduated layers into the chemical reactor with each layer having a different packing factor (see examples 1-3). Regarding claim 64, Fulton further teaches units may have a fluted outer periphery (see Fig. 1). Regarding claim 65, Fulton further teaches that units may have a plurality of recessed notches extending inwardly from the outer periphery toward the medial portion of the units (see Fig. 1). Regarding claim 66, in the units taught by Fulton the four openings substantially surround the central opening between the central opening and the outer periphery to thereby define a ring around the central opening (see Fig. 1). Regarding claim 67, Kramer ('796) discloses a method of fluid distribution in a chemical reactor comprising the steps of providing a layer of a plurality of ceramic filter units (see col. 3, lines 34-40; Figs. 1 and 2); contacting an organic based stream with the layer of the plurality of ceramic filter units and passing the organic-based stream through the layer prior to the organic based feed stream contacting a catalyst be in the chemical reactor (see col. 2, lines 20-25; Figs. 1 and 2). Kramer ('796) fails to disclose the polygonal units having 3 or more passages surrounding a central passage, through which fluid flows. Fulton teaches units having a central opening and four circular/elliptical openings between the

central opening and the periphery (see Fig. 1, third column, fifth row). Note: it is considered that the broadest reasonable definition of ellipse includes circles; just as squares are a special type of rectangle, circles are a special type of ellipse. Polygonal units are also taught (see Fig. 1). It is considered that it would have been obvious to one of ordinary skill in the art to have shaped the units of Kramer according to the teachings of Fulton, because Kramer ('796) explains that alternative unit shapes may be used in the disclosed processes (see Table 2 and col. 4, lines 1-4). Furthermore, Fulton teaches the above-mentioned shapes as an alternative to other shapes including spheres (see page 97) and explains that passages in the units can significantly reduce the amount of material needed, while minimizing lose of strength (see pages 97 and 98, Fig. 3). Fulton also notes in the caption of Fig. 1, that the shapes "represent only a few of the almost limitless variety possible". Regarding claim 69, Kramer ('796) further discloses removing contaminants from a contaminated stream; and providing the contaminated stream to a catalyst bed for further processing in the chemical reactor (see col. 1, lines 52-60; col. 3, lines 4-22; Figs. 1 and 2). Regarding claims 70 and 76, Fulton further teaches that units may have a plurality of recessed notches extending inwardly from the outer periphery toward the medial portion of the units (see Fig. 1). Regarding claim 71-75, square and rectangular shapes are disclosed in Fig. 1 of Fulton. It is explained that the size of the units should be selected based upon various economic trade-offs (see pages 98-99). Kramer provides examples of unit sizes being 0.5 inches and other sizes within the claimed ranges (see example 1-3). Also see applicant's admission on page 3, lines 7-10 regarding prior art thickness of "3/8 inch"

and "approximately 1/8 inch to 1 ¼ inches in diameter". Regarding claim 77, in the units taught by Fulton the four openings substantially surround the central opening between the central opening and the outer periphery to thereby define a ring around the central opening (see Fig. 1). Regarding claims 79-81, the central opening taught by Fulton is circular (see Fig. 1, third column, fifth row). While the other openings are also circular, there is only a mathematically infinitesimal difference between a circle and a non-circular ellipse. As explained by the Senate upon enacting the 1952 Patent Act in Senate Report No. 1979, 82d Cong., 2d Sess. (1952), "Section 103, for the first time in our statute, provides a condition which exists in the law and has existed for more than 100 years, but only by reason of decisions of the courts. An invention which has been made, and which is new in the sense that the same thing has not been made before, may still not be patentable if the difference between the new thing and what was known before is not considered sufficiently great to warrant a patent." The mathematically infinitesimal difference between a circle and a non-circular ellipse "is not considered sufficiently great to warrant a patent". Regarding claims 82-85, Fulton further teaches units with sharp edges as an alternative to units without sharp edges (see Fig. 1). Regarding claim 95, see *In re Harza*, 274 F.2d 669, 124 USPQ 378 (CCPA 1960) regarding the obviousness of duplicating parts.

7. Claims 59, 61-67, 69-85, 94 and 95 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kramer ('796) in view of Fulton as applied to claims 59, 61-67 and 69-85 above, and further in view of Hung et al. (DE 3,539,195). While it is considered that the broadest reasonable definition of ellipse includes circles, as discussed above,

to the extent that someone would argue that circles are excluded from the set of ellipses, Hung et al. (DE 3,539,195) is relied upon as establishing the art recognized equivalence of circular and elliptical openings in ceramic units. As explained in pages 8-10, especially lines 6 and 7 of page 9, of the English translation of Hung ('195), elliptical openings are recognized as and alternative to circular openings. It is considered that it would have been obvious to one of ordinary skill in the art to have substituted elliptical holes for the circular holes discussed above, because circular holes and elliptical holes are recognized in the art as alternative for the same purpose according to Hung ('195) pages 8-10, especially lines 6 and 7 of page 9. Regarding claim 95, see *In re Harza*, 274 F.2d 669, 124 USPQ 378 (CCPA 1960) regarding the obviousness of duplicating parts.

8. Claims 59, 61-67, 69-85, 94 and 95 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kramer (US 4,615,796) in view of Fulton and further in view of the admitted prior art of applicant's declaration filed 28 February 2008, which relates to the BT-750. While, as set forth above, it is considered that the claims are obvious over Kramer (US 4,615,796) in view of Fulton alone, the admitted prior art evidences that it was known in the art to include at least four non-circular ellipse shaped openings in a unit, between a central circular opening and a periphery.

9. Claims 86-93 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kramer (US 4,615,796) in view of "CE Refresher: Catalyst Engineering, Part 2" by John Fulton ("Fulton" herein). Note: the term "trisoid" it understood to be a set of points lying in a plane for each of which the sum of the distances to three given points in said plane

is equal to a constant, in accordance with "Beyond the Ellipse" cited by applicant 10 September 2001 and "A thee-point generalization of the ellipse". Regarding claims 86 and 88-91 Kramer ('796) discloses a method of fluid distribution in a chemical reactor comprising the steps of providing a layer of a plurality of ceramic filter units (see col. 3, lines 34-40; Figs. 1 and 2); contacting an organic based stream with the layer of the plurality of ceramic filter units and passing the organic-based stream through the layer prior to the organic based feed stream contacting a catalyst be in the chemical reactor (see col. 2, lines 20-25; Figs. 1 and 2). Kramer ('796) fails to disclose the units having 3 or more passages surrounding a central passage, through which fluid flows (although annular units, including ones with passages are disclosed in Table 1). Fulton teaches cylindrical units having a central opening and four circular/trisoidal openings between the central opening and the periphery (see Fig. 1, third column, fifth row). Note: it is considered that the broadest reasonable definition of trisoid includes circles; just as squares are a special type of rectangle, circles are a special type of trisoid. See for example the equation below Fig. 2 of "A thee-point generalization of the ellipse", when h and a are zero, the equation is a circle. It is considered that it would have been obvious to one of ordinary skill in the art to have shaped the units of Kramer according to the teachings of Fulton, because Kramer explains that alternative unit shapes may be used in the disclosed processes (see Table 2 and col. 4, lines 1-4). Furthermore, Fulton teaches the above-mentioned shape as an alternative to other shapes including spheres (see page 97) and explains that passages in the units can significantly reduce the amount of material needed, while minimizing lose of strength (see pages 97 and 98,

Fig. 3). See also the admitted prior art of page 3, lines 7-18 of the instant specification. Regarding claim 87, Kramer ('796) discloses a method of fluid distribution in a chemical reactor comprising the steps of providing a layer of a plurality of ceramic filter units (see col. 3, lines 34-40; Figs. 1 and 2); contacting an organic based stream with the layer of the plurality of ceramic filter units and passing the organic-based stream through the layer prior to the organic based feed stream contacting a catalyst be in the chemical reactor (see col. 2, lines 20-25; Figs. 1 and 2). Kramer ('796) fails to disclose polygonal units having 3 or more passages surrounding a central passage, through which fluid flows (although ones with passages are disclosed in Table 1). Fulton teaches cylindrical units having a central opening and four circular/trisoidal openings between the central opening and the periphery (see Fig. 1, third column, fifth row). Note: it is considered that the broadest reasonable definition of trisoids includes circles; just as squares are a special type of rectangle, circles are a special type of trisoid. See for example the equation below Fig. 2 of "A thee-point generalization of the ellipse", when h and a are zero, the equation is a circle. Polygonal units are also taught by Fulton (see Fig. 1). It is considered that it would have been obvious to one of ordinary skill in the art to have shaped the units of Kramer according to the teachings of Fulton, because Kramer explains that alternative unit shapes may be used in the disclosed processes (see Table 2 and col. 4, lines 1-4). Furthermore, Fulton teaches the above-mentioned shape as an alternative to other shapes including spheres (see page 97) and explains that passages in the units can significantly reduce the amount of material needed, while minimizing lose of strength (see pages 97 and 98, Fig. 3). Regarding claims 92 and 93,

see *In re Harza*, 274 F.2d 669, 124 USPQ 378 (CCPA 1960) regarding the obviousness of duplicating parts.

10. Claims 86-93 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kramer (US 4,615,796) in view of Fulton and further in view of the admitted prior art of applicant's declaration filed 28 February 2008, which relates to the BT-750. While, as set forth, above it is considered that the claims are obvious over Kramer (US 4,615,796) in view of Fulton alone, the admitted prior art evidences that it was known in the art to include at least four trisoid shaped openings in a unit, between a central circular opening an a periphery.

Response to Arguments and Declaration

11. Applicant testifies that applicant's previous declaration was incorrect, and that the BT-750 unit is not prior art, stating "In view of the fact that the BT-750 ¾" wagon wheel unit was first offered for sale approximately four (4) years after May 29, 1998, the wagon wheel is not 'prior art' ...". However, firstly, there are other ways in which subject matter may be prior art than through offering for sale, such as being know in this country. Secondly, it has been held that admitted prior art can be relied upon for both anticipation and obviousness, regardless of whether the admitted prior art would otherwise qualify as prior art under the statutory categories of section 102. See Riverwood Int 'l Corp. v. R.A. Jones & Co., 324 F.3d 1346, 1354, 66 USPQ2d 1331, 1337 (Fed. Cir. 2003) and Constant v. Advanced Micro-Devices Inc., 848 F.2d 1560, 1570, 7 USPQ2d 1057, 1063 (Fed. Cir. 1988).

12. Applicant explains that the Criterion Top Bed Catalysts and Support document was first filed with the USPTO 11 November 1998, rather the 1999. However, applicant does not state how long applicant was in possession or aware of the document prior to the actual filing of the IDS with the USPTO.

Conclusion

13. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DAVID L. SORKIN whose telephone number is (571)272-1148. The examiner can normally be reached on Mon.-Fri. 7:30AM-4:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Walter D. Griffin can be reached on 571-272-1447. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/DAVID L. SORKIN/
Primary Examiner, Art Unit 1797

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GLOVER

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(54) **FILTERING MEDIUM AND METHOD FOR CONTACTING SOLIDS-CONTAINING FEEDS FOR CHEMICAL REACTORS**

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(*) Notice: This is a publication of a continued prosecution application (CPA) filed under 37 CFR 1.53(d).

(21) Appl. No.: **09/320,950**

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Related U.S. Application Data

(63) Non-provisional of provisional application No. 60/087,235, filed on May 29, 1998.

Publication Classification

(51) **Int. Cl.**^{7} **B01D 11/00**

(52) **U.S. Cl.** **210/510.1**; 210/506; 210/500.25; 210/500.26

(57) **ABSTRACT**

A filtering medium and method for removing contaminants from an organic-based feed stream which includes the use of a layer of ceramic filter units having a plurality of elliptical or trisoidal openings extending therethrough to filter organic-based feed streams and to provide liquid distribution upstream of the catalyst beds.

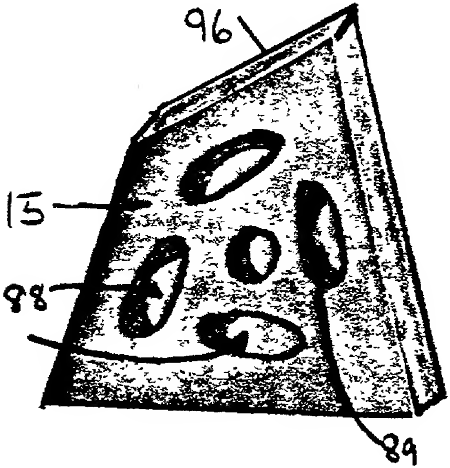


FIG. 1

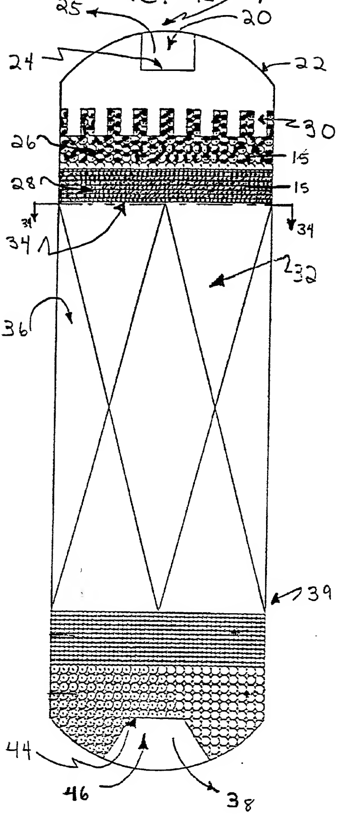


FIG. 2

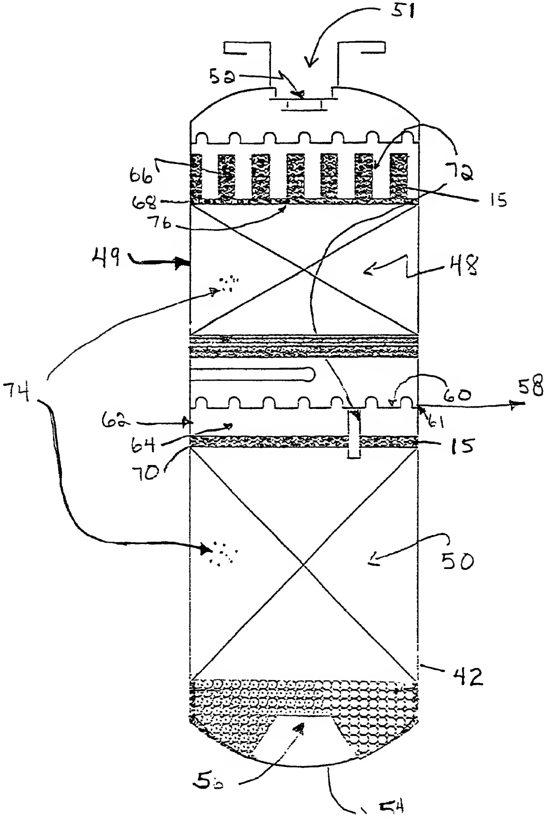
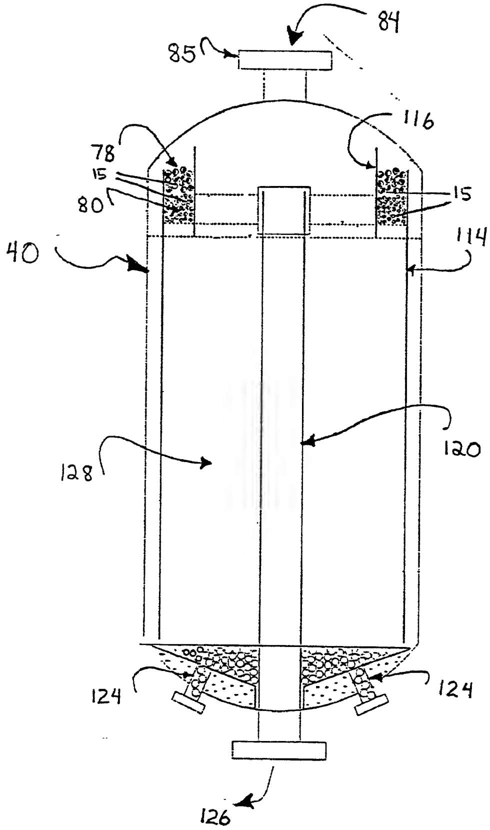


FIG. 3



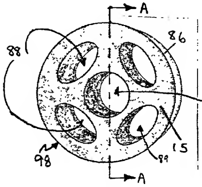


FIG. 4

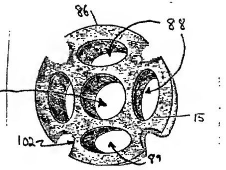


FIG. 5

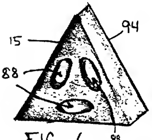


FIG. 6

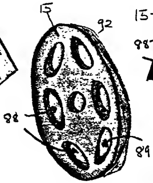


FIG. 12

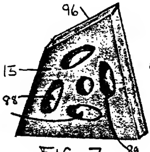


FIG. 7

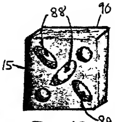


FIG. 13

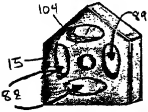


FIG. 8

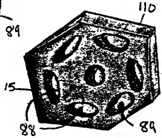
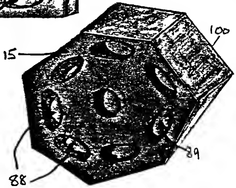


FIG. 9

FIG. 10



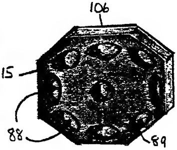


FIG. 11

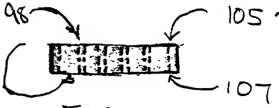


FIG. 15

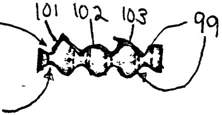


FIG. 16

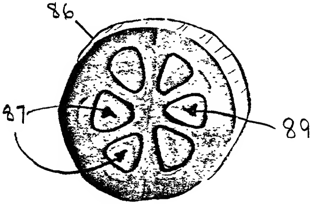


FIG. 14

FILTERING MEDIUM AND METHOD FOR CONTACTING SOLIDS-CONTAINING FEEDS FOR CHEMICAL REACTORS

RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application Ser. No. 60/087,235, filed May 29,1998.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to a filtering medium and method for filtering solids from organic-based feed streams to chemical reactors. In another aspect, this invention relates to a filtering medium and method for providing flow distribution of organic-based feed streams to chemical reactors. More particularly, the invention relates to a filtering medium and method for filtering solids and providing liquid distribution for organic-based feed streams that are subsequently processed in chemical reactors having discrete solid element catalyst bed(s). A further aspect of the invention relates to a filtering medium and method for partially reacting polymer precursors in organic-based feed streams to chemical reactors to reduce fouling of the solid element catalyst bed(s).

[0004] 2. Description of Related Art

[0005] Typically chemical reactor beds include discrete solid catalyst particles contained in one or more fixed beds. Often these beds are supported, or retained, at their inlet and/or outlet by materials which are inert to the reaction. These inert materials may trap all or some solid contaminants such as dirt, iron oxide, iron sulfide, asphaltenes, coke fines, catalyst fines, sediments or other entrained foreign particulate material in the reactor feed stream. The trapping of the contaminants is to prevent undesirable material from plugging, poisoning or otherwise deactivating the catalyst bed. The inert materials, or inerts, traditionally used are typically made of ceramic material in the form of pellets or spheres and typically must be resistant to crushing, high temperatures and/or high pressures. In addition, these materials may facilitate distribution of the feed stream across the catalyst bed in such a manner to reduce channeling through the catalyst bed.

[0006] For the last ten to fifteen years, high void fraction ceramic bed toppings, such as inert ceramic cylindrical filter units with cross sections of approximately ⅜ inch thicknesses and approximately ½ inch to 1¼ inches in diameter with five to ten internal holes of approximately ⅛ inch size, the holes being round or triangular shaped, have been used on the top of fixed bed reactors processing organic feed streams. These bed toppings have been relatively successful at reducing pressure drops by improving liquid distribution. However, attempts to trap particulate matter have not been as successful. Catalyst bed plugging with contaminants such as dirt, iron oxide, iron sulfide, asphaltenes, coke fines, catalyst fines, sediments, or other entrained foreign particulate material remains to be a problem for the industry. Skimming, or removal, of the top portion of the catalyst is required when the filtering capacity of the bed topping or inerts is exhausted resulting in the catalyst itself being used as a filter. Thus, it is highly desirable to increase the efficiency of the inert bed filtration.

[0007] In addition to catalyst fouling by particulate matter in the organic-based stream, polymerization of polymer precursors, e.g., diolefins, found in the organic-based feed stream may also foul the catalyst. In particular, two mechanisms of polymerization, free radical polymerization and condensation-type polymerization, may cause catalyst bed fouling, gumming or plugging. The addition of antioxidants to control free radical polymerization has been found useful where the organic-based feed stream has encountered oxygen. Condensation polymerization of diolefins typically occurs after the organic-based feed is heated. Therefore, filtering prior to the organic-based feed stream entering the reactor may not be helpful to remove these foulants as the polymerization reactions generally take place in the reactors.

[0008] It is highly desirable to increase the efficiency of the inert bed filtration and to control the rate of reaction of the diolefins or other polymer precursors. Thus, the development of a filtering medium and method for filtration that increases the efficiency of the filtering of the contaminated feed stream may also reduce the pressure drop associated with plugging. The method of the present invention for filtration and flow distribution for chemical reactors, when compared with previously proposed prior art methods, has the advantages of: providing more efficient filtering; increasing catalyst life; decreasing catalyst losses; and reducing the need to take the reactor off-line for maintenance when removal or replacement of the inert material or any catalyst that is plugged is required. These benefits may result in both capital and operating savings.

[0009] Disadvantages associated with current filtration and liquid distribution designs and methods in fixed bed chemical reactors may result in poor liquid distribution to the catalyst bed. Partial plugging of the catalyst bed with contaminants, or gumming by reactive diolefins or other polymer precursors, may also cause maldistribution. The maldistribution may result in channeling and corresponding bypassing of portions of the catalyst bed, reducing the catalyst efficiency. Usually, a maldistribution problem is evidenced by radial temperature differences across the reactor. Therefore, the art has sought a medium and method for flow distribution that may spread the liquid more uniformly across and subsequently through the catalyst bed, provide efficient filtering and reduce fouling caused by undesired polymerization reactions.

[0010] Accordingly, prior to the development of the present invention, filtering media and methods for filtering, or distributing, organic-based feed streams to chemical reactors had limited abilities to provide both feed distribution and filtering capacity without plugging or blinding. Relatively large pressure drops across the filtering and/or distribution media of the previous apparatus and methods require excessive capital and operating costs and cause process safety and environmental concerns arising from maintenance required shutdowns and start-ups. Therefore, the art has sought a method for extending the run life of catalyst beds by filtering and distributing organic-based feed streams to chemical reactors which does not: require excessive amounts of catalyst; cause relatively large pressure drops across the bed; require relatively large capacity circulation pumps or compressors; and cause process safety and environmental concerns arising from reactor shutdowns and start-ups.

SUMMARY OF INVENTION

[0011] In accordance with the invention, the foregoing advantages may be achieved through the present media and

methods of filtering and distributing an organic-based feed for chemical reactors. The filtering medium of the present invention includes a plurality of ceramic filter units, at least some of the ceramic filter units having a plurality of openings extending therethrough, and at least some of the openings selected from the group of ellipses or trisoids. The elliptical and trisoidal shaped openings are believed to increase particulate trapping. The elliptical and trisoidal shaped openings create an area of reduced liquid velocity, similar to that in a bend of a river. Sedimentation may occur on the inside of the turn, or river bend, while no particulate trapping occurs on the outside of the turn. The ceramic filter units may be made from any commercially available ceramic precursors including fire clays such as ball clay or silicate-aluminum clays such as montmorillonite clays or preferably, kaolinite clay. Optionally, ceramic precursor powders such as cordierite, mullite, zirconia stabilized with magnesia or calcia, zirconia toughened alumina, and the like may be used. The ceramic filter units may be formed by molding, stamping, pressing or preferably, by extrusion.

[0012] The ceramic filter units of the present invention may have a thickness from about ⅛ to 1½ inches, preferably from about ¼ to ½ inches, more preferably from about ¼ to ⅜ inches. An additional feature of the present invention may include ceramic filter units in a variety of shapes. The shapes may include irregular or closed plane cross-sectional configurations, including but not limited to ellipses and circles, or substantially any polygonal configuration, such as triangles, quadrilaterals, and pentagons, among others. The closed plane cross-sectional configurations may have widths of about ¼ to 3 inches at the widest point. Polygonal cross-sectional configurations used may include sides having lengths of about ⅛ to 3 inches. In particular, substantially circular cross-sectional configurations of about ¼ to 3 inch diameters; ellipses having minor axes of about ¼ to 2 and major axes ranging from about ⅜ to 3 inches; square cross-sectional configurations of about ¼ to 3 inch and rectangles having lengths of about ¼ to 3 inches, and widths of about ¼ to 3 inches may be used.

[0013] The periphery surface of the ceramic filter units may be provided with flutes. As used herein, the term flutes encompasses both flutes and grooves. The ceramic filter units also have top and bottom surfaces. These top and bottom surfaces are generally smooth. However, another feature of the present invention may include contacting the solid particles with the ceramic filter units have top and bottom surfaces, wherein at least one of the top and bottom surfaces are irregularly shaped. A preferred embodiment has irregularity shaped top and bottom surfaces which have ridges, rounded beads, or waves. The irregular surfaces provide protruding areas to contact the entrained solids, reducing the particle velocity below of the fluid, effectively removing entrained solids. The liquid flowing over the irregular surface is induced to form eddies, which in turn forces more entrained solids to contact the ceramic filter units' irregular surface, removing more entrained solids. Another feature of this aspect of the preset invention is that the amplitude and length of the waves of ridges may be adjusted based upon the particles sizes, fluid velocity and viscosity.

[0014] The number and size of the plurality of openings may be varied to change the void fraction of the filter unit, the void fraction of the filter unit being measured as the sum of the areas of openings divided by one cross-sectional area including the area of the openings. The void area of the ceramic filter units may range from about 20 to 70 percentage void area, preferably from about 40 to 65 percentage void area, more preferably from about 50 to 65 percentage void area.

[0015] Another feature of the present invention is to vary the packing factor of the ceramic filter units to affect filtration of varying particle sizes, wherein the packing factor is measured by dividing the surface area of the randomly packed filter units (all surfaces) in square feet by the volume unoccupied by the randomly packed filter units (hereinafter called "void volume") as measured the volume of water at 60° F. required to fill one randomly packed cubic foot. The packing factor may range from about 200 to 500 ft^2/ft^3, preferably from about 220 to 450 ft^2/ft^3, more preferably from about 240 to 400 ft^2/ft^3. In accordance with the invention, the size, shape and void fraction of the ceramic filter units may be varied to change the packing factor of the randomly dumped ceramic filter unit layers.

[0016] In accordance with another aspect of the present invention, at least some of the ceramic filter units are formed of a ceramic which may comprise a substrate having a substantially uniform coating of a selected catalyst including a porous alumina coating with a Group VI-B metal or a Group VIII metal, or both. Preferably, the Group VI-B metal is molybdenum and preferably, the Group VIII metal is either nickel or cobalt. More preferably, the Group VI-B metal and Group VIII metal are impregnated into at least some of the ceramic filter units. This embodiment of the media of the present invention is useful to extend the run life of the catalyst bed. The catalytically active ceramic filter units may be utilized to react diolefins or other polymer precursors and also to act as a filter and distributor. By filtering solids and partially reacting any polymer precursors, e.g., diolefins, fouling of the bed is reduced, effectively extending the run time of the reactor. In another embodiment of this invention, at least some of the ceramic filter units are formed of a ceramic which comprises a porous inorganic oxide selected from the group consisting of alumina, silica, silica-alumina, magnesia, silica-magnesia and titania. At least some of the ceramic filter units of the present invention may also contain a metal oxide, metal nitride, or metal carbide selected from the group consisting of titanium, zirconium, tungsten, silicon or boron. Another feature of this aspect of the present invention is that the ceramic filter units may contain a metal boride selected from the group consisting of titanium, zirconium or tungsten. Still a further aspect of the present invention includes at least some of the ceramic filter units may contain a zeolite selected from the group consisting of zeolite L, zeolite X and zeolite Y.

[0017] The method of the present invention for removing contaminants from an organic-based feed stream, in a chemical reactor may include the steps of providing a layer of ceramic filter units, at least some of the ceramic filter units should have a plurality of openings extending therethrough, at least some of the openings having a shape selected from the group consisting of ellipses or trisoids, the layer of ceramic filter units being in an amount sufficient to filter some or all of the contaminants from the organic-based feed stream, and passing the organic-based feed stream through the layer of ceramic filter units. The organic-based feed stream may be an organic-based liquid, a vapor phase, or

both, and the contaminants may include dirt, iron oxide, iron sulfide, asphaltenes, coke fines, catalyst fines, sediments, other entrained foreign particulate matter or polymer precursors such as diolefins.

[0018] The ceramic filter units of the present invention should be provided in a layer in an amount sufficient to remove some or all of the contaminants from the organic-based feed stream. Preferably, the elliptical or trisoidal shaped openings extend axially along the longitudinal axis of the ceramic filter units. Another feature of the present invention for removing contaminants from a contaminated organic-based feed stream in a chemical reactor includes the steps of providing a layer of ceramic filter units, at least some of the filter units having a plurality of openings extending therethrough, at least some of the openings having a shape selected from the group consisting of ellipses or trisoids, and contacting the contaminated organic-based feed stream with the ceramic filter units to remove the contaminants from the contaminated organic-based feed stream. Another feature of the present invention may include the step of providing a decontaminated organic-based feed stream for further processing.

[0019] More particularly, the invention relates to a process for improving feed quality of organic-based feed streams to chemical reactors by providing a decontaminated organic based feed stream for processing in the chemical reactor. Preferably, the chemical reactors use discrete solid element catalyst beds. As used herein, the term chemical reactors may include hydrotreater, hydrorefiner, hydrocracker, reformer, alkylation, isomerization, and polymerization reactors, among others. The discrete solid catalyst particles may be contained in one or more fixed beds and in either an upflow, downflow or radial flow design.

[0020] An additional feature of the present invention may include the step of using the ceramic filter units of the present invention having an overall thickness which may be varied from about ⅛ to 1½ inches, preferably from about ¼ to ½ inches, more preferably from about ¼ to ⅜ inches. An additional feature of the present invention may include using ceramic filter units in a variety of cross-sectional configurations. The cross-sectional configurations may include free form or polygonal closed plane shapes, including but not limited to ellipses and circles or substantially any polygonal configuration, such as triangles, quadrilaterals, and pentagons, among others. The cross-sectional configurations may include widths of about ¼ to 3 inches at the widest point. Polygonal cross-sectional configurations may include sides having lengths of about ⅛ to 3 inches. In particular, substantially circular cross-sectional configurations of about ¼ to 3 inch diameters; ellipses having minor axes of about ¼ to 2 and major axes ranging from about ⅜ to 3 inches; square cross-sectional configurations of about ¼ to 3 inch and rectangles having lengths of about ¼ to 3 inches, and widths of about ¼ to 3 inches may be used. Additionally, each ceramic filter unit periphery may be provided with a smooth or fluted periphery surface. The ceramic filter units may also be provided top and bottom surfaces that are substantially smooth. Optionally, one or both of the top and bottom surfaces may be provided with an irregular shape.

[0021] The number and size of the plurality of openings used may be varied to change the void fraction of the ceramic filter units. The void fraction of the ceramic filter units used may range from about 20 to 70 percentage void area, preferably from about 40 to 65 percentage void area, more preferably from about 50 to 65 percentage void area. Another feature of the present invention is to vary the packing factor of the ceramic filter units used to affect filtration of varying particle sizes.

[0022] The packing factor used may range from about 200 to 500 ft^2/ft^3, preferably from about 220 to 450 ft^2/ft^3, more preferably from about 240 to 400 ft^2/ft^3. In accordance with the invention, the size, shape and void area of the ceramic filter units used may be varied to change the packing factor of the randomly dumped ceramic filter unit layers.

[0023] The method of the present invention is useful to extend the run life of the catalyst bed. Catalytically active ceramic filter units may be utilized to react diolefins or other polymer precursors and also to act as a filter and distributor. By filtering solids and partially reacting any polymer precursors, e.g., diolefins, fouling of the bed is reduced, effectively extending the run time of the reactor. In accordance with another aspect of the present invention, the step of contacting the contaminated organic-based feed stream with the ceramic filter units may include depositing a catalyst on at least some of the ceramic filter units prior to contacting the contaminated organic-based feed stream. Another feature of this aspect of the present invention may include the use of at least some ceramic filter units having a plurality of openings selected from the group consisting of ellipses and trisoids as a substrate having a substantially uniform coating of a selected catalyst including a porous alumina coating with a Group VI-B metal or a Group VIII metal, or both. Preferably, the Group VI-B metal is molybdenum and preferably, the Group VIII metal is either nickel or cobalt. More preferably, the Group VI-B metal and Group VIII metal are impregnated into at least some of the ceramic filter units having a plurality of openings extending therethrough, at least some of the openings having a shape selected from the group consisting of ellipses and trisoids. In another embodiment of this invention, at least some of the ceramic filter units used may comprise a porous inorganic oxide selected from the group consisting of alumina, silica, silica-alumina, magnesia, silica-magnesia and titania. At least some of the ceramic filter units used in the present invention may also be a metal oxide, metal nitride, or metal carbide selected from the group consisting of titanium, zirconium, tungsten, silicon or boron. Another feature of this aspect of the present invention is using at least some ceramic filter units comprising a metal boride selected from the group consisting of titanium, zirconium or tungsten. Still a further aspect of the present invention includes using at least some ceramic filter units comprising a zeolite selected from the group consisting of zeolite L, zeolite X and zeolite Y.

[0024] In accordance with another aspect of the present invention, the present method of flow distribution in a chemical reactor includes the steps of: providing a layer of ceramic filter units, at least some of the ceramic filter units having a plurality of openings extending therethrough, at least some of the openings having a shape selected from the group consisting of ellipses and trisoids, at least some of the ceramic filter units having a plurality of flow passageways defined by the plurality of openings extending through the ceramic filter units; contacting an organic-based feed stream with the layer of ceramic filter units; and subdividing the organic-based feed stream into a plurality of smaller fluid

streams by passing the organic-based feed stream through the plurality of flow passageways defined by the plurality of openings. A further feature of this aspect of the present invention may include the steps of removing contaminants from a contaminated organic-based feed stream, and providing a decontaminated and uniformly spread organic-based feed stream to a catalyst bed for further processing in the chemical reactor.

[0025] The method of the present invention for filtering organic-based feed streams in chemical reactors, when compared with prior art methods, has the advantages of: reducing the volume of ceramic materials required; lowering capital costs; improving the filtration of the solid particular matter from the feed streams; decreasing the pressure drop across the system; increasing run time of the reactor; lowering operating costs; increasing process safety; and reducing environmental concerns.

BRIEF DESCRIPTION OF DRAWINGS

[0026] In the drawings:

[0027] **FIG. 1** is partial a cross-sectional side view of a single fixed bed chemical reactor showing a specific embodiment of the present invention;

[0028] **FIG. 2** is a partial cross-sectional side view of a multiple fixed bed chemical reactor showing another embodiment of the present invention;

[0029] **FIG. 3** is a partial cross-sectional side view of a radial flow reactor showing another embodiment of the present invention;

[0030] **FIG. 4** is a perspective view of a circular shaped ceramic filter unit with a smooth periphery having a plurality of elliptical openings extending therethrough in accordance with the present invention;

[0031] **FIG. 5** is a perspective view of a circular shaped ceramic filter unit with a fluted periphery having a central circular opening surrounded with a plurality of elliptical openings wherein all openings extend axially through the longitudinal axis of the ceramic filter unit in accordance with the present invention;

[0032] **FIG. 6** is a perspective view of triangular shaped ceramic filter unit having a plurality of elliptical openings extending therethrough in accordance with the present invention;

[0033] **FIG. 7** is a perspective view of a quadrilateral shaped ceramic filter unit having a plurality of elliptical openings extending therethrough in accordance with the present invention;

[0034] **FIG. 8** is a perspective view of a pentagonal shaped ceramic filter unit having a plurality of elliptical openings extending therethrough in accordance with the present invention;

[0035] **FIG. 9** is a perspective view of a hexagonal shaped ceramic filter unit having a plurality of elliptical openings extending therethrough in accordance with the present invention;

[0036] **FIG. 10** is a perspective view of a heptagonal shaped ceramic filter unit having a plurality of elliptical openings extending therethrough in accordance with the present invention;

[0037] **FIG. 11** is a perspective view of an octagonal shaped ceramic filter unit having a plurality of elliptical openings extending therethrough in accordance with the present invention;

[0038] **FIG. 12** is a perspective view of an elliptical shaped ceramic filter unit having a plurality of elliptical openings extending therethrough in accordance with the present invention; and

[0039] **FIG. 13** is a perspective view of a square shaped ceramic filter unit having a plurality of elliptical openings extending therethrough in accordance with the present invention.

[0040] **FIG. 14** is a perspective view of a circular shaped ceramic filter unit having a plurality of trisoidal openings extending therethrough in accordance with the present invention.

[0041] **FIG. 15** is a side view, taken along the cross-section A-A of **FIG. 4**, showing a ceramic filter unit having substantially smooth top and bottom surfaces.

[0042] **FIG. 16** is a side view, taken along the cross-section A-A of **FIG. 4**, showing a ceramic filter unit having irregularly shaped top and bottom surfaces.

[0043] While the invention will be described in connection with the preferred embodiment, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and the scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION AND SPECIFIC EMBODIMENTS

[0044] With reference to **FIG. 1**, unless otherwise noted, for treatment of an organic-based feed stream, a single fixed bed chemical reactor **22** is shown. If the reactor **22** is of a downflow configuration, the contaminated organic-based feed stream **20** will enter the reactor **22** at the inlet **24** and exit the outlet **44** as stream **38**. The invention may be used in fixed bed chemical reactors. Preferably, the present invention is used in one or more fixed beds, in either an upflow or downflow or radial flow configuration. As used herein, the term "chemical reactors" may include hydrotreaters, hydrorefiners, hydrocrackers, reformers, alkylation, isomerization and polymerization reactors, among others. Contaminants typically found in the feed stream include dirt, iron oxide, iron sulfide, asphaltenes, coke fines, catalyst fines, sediments or other entrained foreign particulate material.

[0045] Still with reference to **FIG. 1,** a layer of ceramic filter units **15** (FIGS. **4-16**), at least some having a plurality of openings **89** extending therethrough, at least some of the openings having a shape selected from the group consisting of ellipses **88** (FIGS. **4-5**) or trisoids **87** (**FIG. 14**). A layer **26**, preferably layers **26**, **28**, of ceramic filter units **15**, wherein at least some of the ceramic filter units have a plurality of elliptical shaped openings **88** (FIGS. **4-5**) or trisoidal shaped openings **87** (**FIG. 14**) is provided in the reactor, or vessel, **22** in an amount sufficient to filter the contaminants from the organic-based feed stream **20**. Optionally, the number or size of elliptical shaped openings

88 (FIGS. 4-5), trisoidal shaped openings 87 (FIG. 14) or other shaped openings 108 (FIGS. 4-5) may be varied to change the void fraction of the ceramic filter units 15.

[0046] Optionally, but preferably, the size, shape and thickness of the ceramic filter units may also be varied to change the packing factor for the layer of ceramic filter units 26. As illustrated in FIG. 1, multiple layers 26, 28 may be provided wherein the packing factor of layer of ceramic filter units 26, 28 is graduated from a low value (larger void volume) in layer 26 to a higher value (smaller void volume) in layer 28 as the incoming organic-based feed stream flows through the ceramic filter units 15. The packing factors of the layers 26, 28 of ceramic filter units 15 may be graduated from a smaller packing factor to a larger packing factor to lessen the pressure drop through the reactor attributable to filtering of the suspended solids. Optionally, the present invention may be practiced with or without conventional basket screens 30.

[0047] The ceramic filter units 15 may be made from any commercially available ceramic precursors fire clays for example, ball clays or silicate-aluminum clays such as montmorillonite or preferably kaolinite clays such as thosc found in the Southeastern United States. Optionally, ceramic precursors such as cordierite, mullite, magnesia aluminia, zirconia stabilized with magnesia or calcia, zirconia toughened alumina, and the like may also be used.

[0048] Still with reference to FIG. 1, in addition to filtcring the contaminated organic-based feed stream 20, the ceramic filter units 15 may also enable a uniform distribution and flow of the incoming organic-based feed stream 20 to the catalyst bed 32. The incoming organic-based feed stream 20 may be distributed by passing the organic-based feed stream through a plurality of flow passageways 87, 88, 89, 108 (FIGS. 4, 5, 14). The flow passageways 87, 88, 89, 108 (FIGS. 4, 5, 14) are defined by the elliptical shaped openings 88 (FIG. 4), trisoidal shaped openings 87 (FIG. 14) or optionally, other shapes, such as circular openings 108 (FIGS. 4-5) extending through the ceramic filter units 15. Preferably, the openings 89 (FIGS. 4, 5, 14) extend axially through the ceramic filter units along their longitudinal axis. The layers 26, 28, of ceramic filter units 15 distribute the incoming organic-based feed stream 20 into a plurality of smaller fluid streams by resubdividing, a plurality of times, the smaller streams so that the incoming organic-bascd fced stream 20 is spread across the fluid entry cross section 34, taken along line 34-34, of the catalyst bed 32.

[0049] The organic-based feed stream 20 is reacted in the catalyst bed 32. Preferably the catalyst bed 32 contains discrete solid catalyst particles 36. Alternately, the filtering medium, or ceramic filter units, 15 may also be used in an upflow reactor configuration wherein the contaminated organic-based feed 46 would instead enter thc vessel at the outlet 44 at the lower end 39 and the rcacted organic-based stream 25 would exit the reactor at the inlet 24 at the upper end 47 of reactor 22.

[0050] As previously discussed, another advantage of thc present invention is to react partially activated or activated ceramic filter units 15 with polymer precursors in a contaminated organic-based feed stream 20. Condensation polymerization of diolefins may occur in the reactor bed 32 after the contaminated organic-based feed stream 20 is heated, generally prior to introduction into the chemical reactor 22, thereby forming foulants in the reactor bed 32 itself which may gum or plug the bed 32. As the foulants form in the bed, they cannot be filtered from the contaminated organicl based feed stream 20 before flowing across the fluid entry cross section 34. Therefore, the laycr or layers 26, 28 of ceramic filter units 15 may be coated with an alumina powder which may also act as a substrate for catalyst materials to form activated ceramic filtcr units 15.

[0051] As used herein, an "activated support" means: a ceramic filter unit 15, having at least some elliptical shaped openings 88 (FIGS. 4-5) or trisoidal shaped openings 87 (FIG. 14), which has been impregnated with catalyst materials; a ceramic filter unit 15 having at least some elliptical shaped openings 88 (FIGS. 4-5), or trisoidal shaped openings 87 (FIG. 14), which may contain an oxide, nitride, or carbide of a metal; or a ceramic filter unit 15 having at least some elliptical shaped openings 88 (FIGS. 4-5), or trisoidal shaped openings 87 (FIG. 14), which contains zeolite or porous inorganic oxides, e.g., alumina, silica, silica-alumina, magnesia, silica-magnesia or titania. As used herein, a "partially activated support" means an activated support material which has been purposefully made less active, or partially deactivated, in order to achieve a slower reaction rate or to partially react the materials contacted.

[0052] Coated ceramic filter units 15 may also be used, wherein the coating may comprise one of several conventional catalysts. Alumina may be used as an active coating. Preferably, alumina may be used as a support. The catalyst according to this invention preferably comprises a metal of Group VI-B or a member of Group VIII, or both, impregnated into an alumina-based support. Accordingly, the catalyst may comprise at least one of chromium, molybdenum and tungsten in combination with at least one of iron, nickel, cobalt, platinum, palladium and iridium. Of the Group VI-B metals, molybdenum is most preferred. The catalyst preferably will contain from about 2% to about 14% by weight of Group VI-B metal. Of the Group VIII metals, nickel and cobalt are most preferred. The amount of Group VIII metal in the catalyst is preferably from about 0.5% to about 10% by weight.

[0053] With reference to FIG. 2, a multiple fixed bed chemical reactor 49 having two fixed catalyst beds 48, 50 with ceramic filter units 15 will be described. The reactor 49 is illustrated in a downflow configuration, wherein the contaminated organic-based feed stream 51 will enter the reactor 49 at the inlet 52 and the reacted organic-based stream 54 will exit the reactor at the outlets 56, 61. A partially reacted organic-based stream 58 may be accumulated at the outlet 61 of the first fixed bed 48 and withdrawn at the collector tray 60. The partially reacted organic-based stream 58 may be heated or quenched or otherwise treated before reintroduction into the reactor 49 as a partially reacted organic-based feed stream 62 at the mixing chamber 64. The partially reacted organic-based stream 58 may be removed for redistribution, heating, or other processing steps as required before reintroducing the partially reacted organic-based feed stream 62 into the reactor 49 for reaction with a succeeding catalyst bed 50. An additional layer 70 of ceramic filter units 15 having at least some elliptical shaped openings 88 (FIGS. 4-5), or trisoidal shaped openings 87 (FIG. 14), may be provided for filtration and distribution to remove any contaminants entrained from or formed by the processing equipment used in the additional processing steps

such as dirt, iron oxide, iron sulfide, asphaltenes, coke fines, catalyst fines, sediments, or other entrained foreign particulate material. The reacted stream **54** exits the lower end **42** of the reactor **49** at the outlet **56**.

[**0054**] Layers **66, 68, 70** of ceramic filter units **15** are provided in the reactor **49** below the inlet **52** and mixing chamber **64** in an amount sufficient to filter the organic-based feed stream **51** and the partially reacted organic-based feed stream **62**. Optionally, the size, shape and thickness of the cross sections may also be varied to change the packing factor for the layers **66, 68** of ceramic filter units **15**. Multiple layers may be provided wherein the packing factor of the layered ceramic filter units **66, 68** is graduated from a low value (larger void volume) in layer **66** to a higher value (smaller void volume) in layer **68** as the incoming organic-based feed stream flows through the ceramic filter units **15**. Optionally, the present invention may be practiced with, or without, conventional basket screens **72**. Preferably, the fixed catalyst beds **48, 50** contain discrete solid catalyst particles **74**.

[**0055**] As previously discussed, an advantage of the present invention is that it may also be used to distribute the organic-based feed stream. The organic-based feed stream **51** may also be distributed while being filtered by subdividing the incoming organic-based feed into a plurality of smaller fluid streams. The organic-based feed stream **51** may be distributed or spread across the fluid entry cross section of the catalyst bed **76** by passing the organic-based feed stream **51** through a layer **66** or layers **66, 68** of ceramic filter units **15**. The ceramic filters **15** resubdivide, a plurality of times, the smaller streams in a plurality of flow passageways **87, 88, 89, 108** (**FIGS. 4, 5, 14**). The organic-based feed **51** is then reacted in the catalyst bed **48**, before being withdrawn as a partially reacted organic-based stream **58** at the collector plate **60**. The method of filtration and distribution is then repeated for the partially reacted organic-based feed stream **62** as it flows into the mixing chamber **64** and passes through the ceramic filter units layer **70**.

[**0056**] A further advantage of the present invention is that at least some of the ceramic filter units **15** may be activated or impregnated with catalyst to react with polymer precursors in organic-based feed streams **51, 62**. As depicted in **FIG. 2**, layers **66, 68, 70** of ceramic filter units **15** at least some of the ceramic filter units having a plurality of openings **89** extending therethrough, at least some of the opening having a shape selected from the group consisting of ellipses **88** (FIGS. **4-5**), or trisoids **87** (**FIG. 14**), may contain an activated support including porous inorganic oxides preferably selected from the group consisting of alumina, silica, silica-alumina, magnesia, silica-magnesia or titania or zeolites. The zeolites are preferably selected from the group consisting of zeolite L, zeolite X, and zeolite Y, which may be added to the ceramic filter units **15** as a substrate for catalyst materials. Optionally, the ceramic filter units **15** may be impregnated with catalyst materials which may be an oxide, nitride, carbide or boride of a metal as disclosed in U.S. Pat. No. 5,399,535, which is hereby incorporated by reference to the extent it is not inconsistent with the present invention.

[**0057**] Activated, or partially activated, ceramic filter units **15** may be used to control the hydrogenation rate of the diolefins or other polymer precursors to prevent fouling or gum formation. When endothermic reactions require the addition of heat to the partially reacted organic-based stream **58**, preferably the layer **70** of ceramic filter units **15** is also activated or partially activated. The invention may also be practiced with at least some coated ceramic filter units **15**, wherein the coating may comprise one of several conventional catalysts. Alumina may be used on an active coating or support. The catalyst according to this invention preferably comprises a metal of Group VI-B or a member of Group VIII, or both, impregnated into the active coating or support on the ceramic filter units **15**. Accordingly, the catalyst may comprise at least one of chromium, molybdenum and tungsten in combination with at least one of iron, nickel, cobalt, platinum, palladium and iridium. Of the Group VI-B metals, molybdenum is most preferred. The catalyst preferably will contain from about 2% to about 14% by weight of Group VI-B metal. Of the Group VIII metals, nickel and cobalt are most preferred. The amount of Group VIII metal in the catalyst is preferably from about 0.5% to about 10% by weight. More preferably, the Group VI-B metal and Group VIII metal are impregnated directly into the ceramic filter units.

[**0058**] With reference to **FIG. 3**, for treatment of a contaminated organic-based feed in vapor form, a radial flow fixed bed chemical reactor **40** is illustrated. The contaminated organic-based feed in vapor form **84** will enter the radial flow reactor **40** at the inlet **85**. A layer **78** of ceramic filter units **15**, more preferably layers **78, 80** of ceramic filter units **15**, is provided in the reactor, or vessel **40**, between a deflection baffle **116** and the scallop **114**. The layers **78, 80** of ceramic filter units **15** aid in filtering contaminants such as entrained dirt, iron oxide, iron sulfide, asphaltenes, coke fines, catalyst fines, sediments, or other foreign particulate material entrained in the contaminated organic-based vapor feed **84**. Following filtration, the vapor is reacted in the fixed catalyst bed **128**. The reacted organic stream **126** is discharged through the center pipe **120**.

[**0059**] **FIGS. 4 and 5** illustrate a specific embodiment of the present invention as a ceramic filter unit **15** having a circular shape, or cross-sectional configuration, **86** and at least some elliptical shaped openings **88** (FIGS. **4-5**). Trisoidal shaped openings **87** may also be used (**FIG. 14**). Optionally, the ceramic filter units **15** may have other shaped openings **108** mixed with the elliptical shaped openings **88** (FIGS. **4-5**) or the trisoidal shaped openings **87** (**FIG. 14**). The other shaped openings may have a circular shape, as illustrated in FIGS. **4-5** or may be irregular or other closed plane shapes, such as squares, clover leaves, or diamonds, among others. Optionally, the periphery surface of the ceramic filter units **15** may be smooth as shown by arrow **98** (**FIG. 4**) or be provided with flutes, or grooves, **102** (**FIG. 5**). As to the ceramic filter units **15** of **FIGS. 4 and 5**, although four openings **88** disposed about a circular shaped opening **108** are shown, it will be apparent to one of ordinary skill in the art that a greater, or smaller, number of openings **88** may be provided. For example, three openings **88** or five openings **88**, could be utilized.

[**0060**] With reference to **FIG. 15**, the top surface **105** and bottom surface **107** of the ceramic filter units **15** may also be used to contact solid particles and effectively remove the entrained solids by reducing the particle velocity below that of the fluid. Irregularly shaped top and bottom surfaces **105, 107** (**FIG. 16**) may augment this process. The amplitude and

length of the ridges, rounded beads of waves may be adjusted based upon the particle sizes, fluid velocity and viscosity.

[0061] Other cross-sectional configurations used for the ceramic filter units may include triangles **94** (**FIG. 6**), quadrilaterals **96** (**FIG. 7**), pentagons **104** (**FIG. 8**), hexagons **110** (**FIG. 9**), heptagons **100** (**FIG. 10**), octagons **106** (**FIG. 11**), ellipses **92** (**FIG. 12**), and squares **90** (**FIG. 13**), among others. Each shape may be sized to individual specifications. Sizes for the shapes used may include circular shapes of about ¼ to 3 inches in diameter; elliptical shapes with major axes of about ¼ to 2 inches and minor axes of about ⅜ to 3 inches; and polygonal shapes with individual sides of the polygon of about ⅛ to 3 inches.

[0062] It is to be understood that the invention is not to be limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as obvious modifications and equivalents will be apparent to one skilled in the art. For example, a non-uniform thickness cross section could be utilized rather than a uniform thickness for decreasing the packing factor, if desired. Accordingly, the invention is therefore to be limited only by the scope of the appended claims.

What is claimed:

1. A filtering medium for use in chemical reactors, comprising a plurality of ceramic filter units, at least some of the ceramic filter units having a plurality of openings and at least some of the openings extending therethrough having a shape selected from the group consisting of ellipses and trisoids.

2. The filtering medium of claim 1, wherein at least some of the ceramic filter units have a thickness of about ⅛ to 1½ inches.

3. The filtering medium of claim 1, wherein at least some of the ceramic filter units have closed plane shaped cross-sectional configuration, each having a width of about ¼ to 3 inches at the widest point.

4. The filtering medium of claim 1, wherein at least some of the ceramic filter units have a polygonal cross-sectional configuration having a plurality of sides, the configuration selected from the group consisting of triangles, quadrilaterals, squares, rectangles, pentagons, hexagons, heptagons and octagons, each of the sides having a length of about ⅛ to 3 inches.

5. The filtering medium of claim 1, wherein at least some of the ceramic filter units have an elliptical cross-sectional configuration selected from the group consisting of ellipses having minor axes ranging from about ¼ to 2 inches and major axes ranging from about ⅜ to 3 inches and circles having diameters ranging from about ¼ to 3 inches.

6. The filtering medium of claim 1, wherein at least some of the ceramic filter units have a fluted surface.

7. The filtering medium of claim 1, wherein the ceramic filter units have top and bottom surfaces, wherein at least one of the top and bottom surfaces are irregularly shaped.

8. The filtering medium of claim 1, wherein the at least some of the ceramic filter units have about a 20 to 70 percentage void area.

9. The filtering medium of claim 1, wherein the ceramic filter units, after being packed into the chemical reactor, form a filtration layer having about a 200 to 500 ft^2/ft^3 packing factor.

10. The filtering medium of claim 1, wherein the at least some of the ceramic filter units are formed of a ceramic which comprises a substrate having a substantially uniform coating of a selected catalyst including a porous alumina coating with one Group VI-B metal.

11. The filtering medium of claim 10, wherein the Group VI-B metal is molybdenum.

12. The filtering medium of claim 1, wherein the at least some of the ceramic filter units comprise a substrate having a substantially uniform coating of a selected catalyst including a porous alumina coating with one Group VIII metal.

13. The filtering medium of claim 12, wherein a Group VIII metal is nickel or cobalt.

14. The filtering medium of claim 1, wherein a Group VI-B metal is impregnated into at least some of the ceramic filter units.

15. The filtering medium of claim 1, wherein a Group VIII metal is impregnated into at least some of the ceramic filter units.

16. The filtering medium of claim 1, wherein thc at least some of the ceramic filter units are formed of a ceramic which contain a porous inorganic oxide selected from the group consisting of alumina, silica, silica-alumina, magnesia, alumina and titania.

17. The filtering medium of claim 1, wherein the at least some of the ceramic filter units contain a metal oxide selected from the group consisting of titanium, tin, lead, zirconium, ruthenium, tungsten, yttrium, nickel, magnesium, calcium, aluminum, silicon or boron.

18. The filtering medium of claim 1, wherein the at least some of the ceramic filter units contain a metal nitride selected from the group consisting of titanium, zirconium, tungsten, silicon or boron.

19. The filtering medium of claim 1, wherein the at least some of the ceramic filter units contain a metal carbide selected from the group consisting of titanium, zirconium, tungsten, silicon or boron.

20. The filtering medium of claim 1, wherein the at least some of the ceramic filter units contain a metal boride selected from the group consisting of titanium, zirconium or tungsten.

21. The filtering medium of claim 1, wherein the at least some of the ceramic filter units contain a zeolite selected from the group consisting of zeolite L, zeolite X and zeolite Y.

22. A method of removing contaminants from a contaminated organic-based feed stream, in a chemical reactor, comprising the steps of:

(a) providing a layer of ceramic filter units, at least some of the ceramic filter units having a plurality of openings extending therethrough, at least some of the openings having a shape selected from the group consisting of ellipses and trisoids, the layer of ceramic filter units being in an amount sufficient to filter the contaminant from the organic-based feed stream; and

(b) passing the contaminated organic-based feed stream through the layer of ceramic filter units.

23. A method of removing contaminants from a contaminated organic-based feed stream in a chemical reactor, comprising the steps of:

(a) providing a layer of ceramic filter units, at least some of the ceramic filter units having a plurality of openings extending therethrough, at least some of the openings having a shape selected from a group consisting of ellipses and trisoids;and

(b) contacting the contaminated organic-based feed stream with the ceramic filter units to remove the contaminants from the contaminated organic-based feed stream.

24. The method of claim 23, including the step of providing a decontaminated organic-based feed stream for further processing in the chemical reactor.

25. The method of claim 23, including the step of utilizing at least some ceramic filter units having a thickness of about ⅛ to 1½ inches.

26. The method of claim 23, including the step of utilizing at least some ceramic filter units having a closed plane shape cross-sectional configuration, each having a width of about ¼ to 3 inches at the widest point.

27. The method of claim 23, including the step of utilizing at least some ceramic filter units having a polygonal cross section, selected from the group consisting of triangles, quadrilaterals, squares, rectangles, pentagons, hexagons, heptagons and octagons, each side of the polygon to have a length of about ⅛ to 3 inches.

28. The method of claim 23, including the step of utilizing at least some ceramic filter units having an elliptical cross section selected from the group consisting of ellipses having minor axes ranging from about ¼ to 2 inches and major axes ranging from about ⅛ to 3 inches and circles having diameters ranging from about ¼ to 3 inches.

29. The method of claim 23, including the step of utilizing at least some ceramic filter units having a fluted surface.

30. The method of claim 23, including the step of utilizing at least some ceramic filter units having top and bottom surfaces, wherein at least one of the top and bottom surfaces are irregularly shaped.

31. The method of claim 23, including the step of utilizing at least some ceramic filter units having about a 20 to 70 percentage void area.

32. The method of claim 23, including the step of utilizing at least some ceramic filter units forming a filtration layer having about a 200 to 500 ft^2/ft^3 packing factor.

33. The method of claim 23, wherein the step of contacting the contaminated organic-based feed stream with the ceramic filter units includes depositing a catalyst on at least some of the ceramic filter units.

34. The method of claim 23, including the step of utilizing at least some ceramic filter units as a ceramic substrate having a substantially uniform coating of a selected catalyst including a porous alumina coating with one Group VI-B metal.

35. The method of claim 34, wherein the Group VI-B metal is molybdenum.

36. The method of claim 23, including the step of utilizing at least some ceramic filter units as a ceramic substrate having a substantially uniform coating of a selected catalyst including a porous alumina coating with one Group VIII metal.

37. The method of claim 36, wherein a Group VIII metal is nickel or cobalt.

38. The method of claim 23, including the step of utilizing a Group VI-B metal impregnated into at least some of the ceramic filter units.

39. The method of claim 23, including the step of utilizing a Group VIII metal impregnated into at least some of the ceramic filter units.

40. The method of claim 23, including the step of utilizing at least some ceramic filter units contain a porous inorganic oxide selected from the group consisting of alumina, silica, silica-alumina, magnesia, silica-magnesia and titania.

41. The method of claim 23, including the step of utilizing at least some ceramic filter units contain a met al oxide selected from the group consisting of titanium, tin, lead, zirconium, ruthenium, tungsten, yttrium, nickel, magnesium, calcium, aluminum, silicon or boron.

42. The method of claim 23, including the step of utilizing at least some ceramic filter units contain a metal nitride selected from the group consisting of titanium, zirconium, tungsten, silicon or boron.

43. The method of claim 23, including the step of utilizing at least some ceramic filter units contain a metal carbide selected from the group consisting of titanium, zirconium, tungsten, silicon or boron.

44. The method of claim 23, including the step of utilizing at least some ceramic filter units contain a metal boride selected from the group consisting of titanium, zirconium or tungsten.

45. The method of claim 23, including the step of utilizing at least some ceramic filter units contain a zeolite selected from the group consisting of zeolite L, zeolite X and zeolite Y.

46. A method of fluid distribution in a chemical reactor comprising the steps of:

(a) providing a layer of ceramic filter units, at least some of the ceramic filter units having a plurality of openings extending therethrough, and at least some of the openings having a shape selected from the group consisting of ellipses and trisoids, at least some of the ceramic filter units having a plurality of flow passageways defined by the plurality of openings extending through the ceramic filter units;

(b) contacting an organic-based feed stream with the layer of ceramic filter units; and

(c) subdividing the organic-based feed stream into a plurality of smaller fluid streams by passing the organic-based feed stream through the plurality of flow passageways defined by the plurality of openings.

47. The method of claim 46 including the steps of: removing contaminants from a contaminated organic-based feed stream; and providing a decontaminated and uniformly spread organic-based feed stream to a catalyst bed for further processing in the chemical reactor.

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